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October 29, 2019
VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

REDACTED – FOR PUBLIC INSPECTION

Re: Ex Parte Presentation, Request by Metrom Rail, LLC for Waiver of Sections 15.519(a) and 15.519(c) of the Commission's Rules, ET Docket No. 18-284.

Dear Ms. Dortch:

Pursuant to Section 1.1206(b) of the Commission's Rules, 47 C.F.R. § 1.1206(b), Metrom Rail, LLC ("Metrom") provides this *ex parte* filing to respond to questions raised by the Commission staff. Attached is a detailed summary of the system characteristics of the Metrom AURA system. In particular, the technical summary provides details on how the sensors and wayside points could be configured as well as details on how the system would manage any harmful interference from licensed services. Finally, the attachment describes the role the AURA system may play in various deployment scenarios to help provide for safer transit by local rail systems.

Pursuant to Section 1.1206 of the Commission's rules, a copy of this letter is being filed in ECFS. Please do not hesitate to contact the undersigned with any questions.

Sincerely,

/s/ Thomas S. Dombrowsky, Jr.

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Attachment

cc: Julius Knapp, Michael Ha, Jamison Prime, Karen Rackley, Syed Hasan

Metrom Rail AURA UWB Solution

Overview

Metrom Rail has developed the AURA train protection solution which utilizes the robust and precise ranging capabilities of Ultra-Wideband (UWB) radio technology. This solution was built from the success of the collision avoidance system that has been in use for six years on thousands of Class 1 railroad maintenance-of-way vehicles. The collision avoidance system complies with the technical requirements for hand held UWB systems (Sections 15.519 and 15.521 of the Commission's rules). The system has had no reported cases of interference since deployment.

The UWB radio technology allows for a variety of deployment opportunities tailored to customer needs. Depending on the agency, the AURA system can be a non-vital safety overlay system or a full train control system. Each of these solutions has different safety requirements. While developing the train protection solutions, Metrom Rail has worked closely with Rail Safety Consulting (RSC), an industry-recognized rail safety assessor, to ensure the highest levels of safety in all products. Prior to Proof of Concept demonstrations, RSC has assisted in developing the safety case documentation that allowed the work to proceed in both Boston and New York.

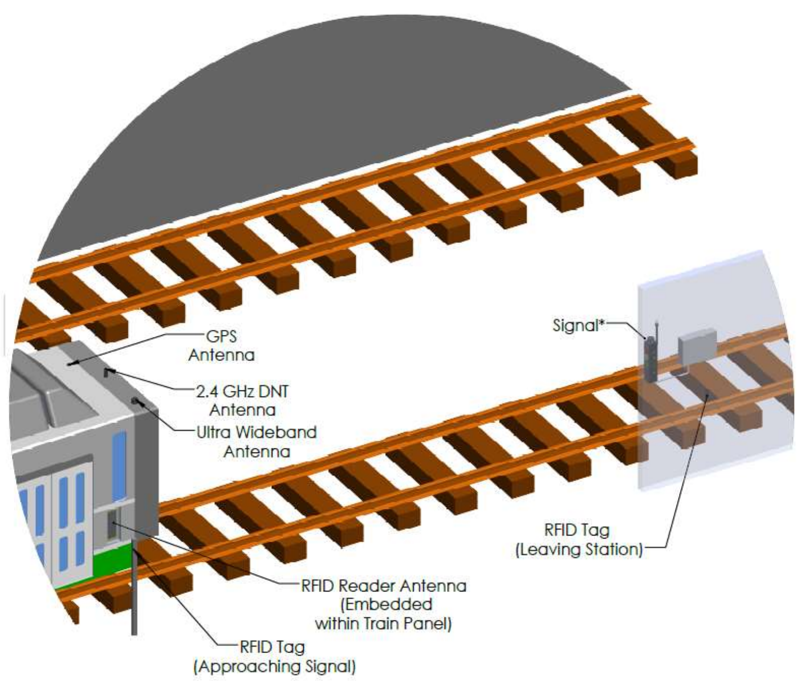
UWB Systems

Metrom Rail has successfully demonstrated AURA systems in both Boston and New York. While both solutions include UWB as the core technology, the complexity of the solutions varies according to the specific application.

Boston MBTA Solution

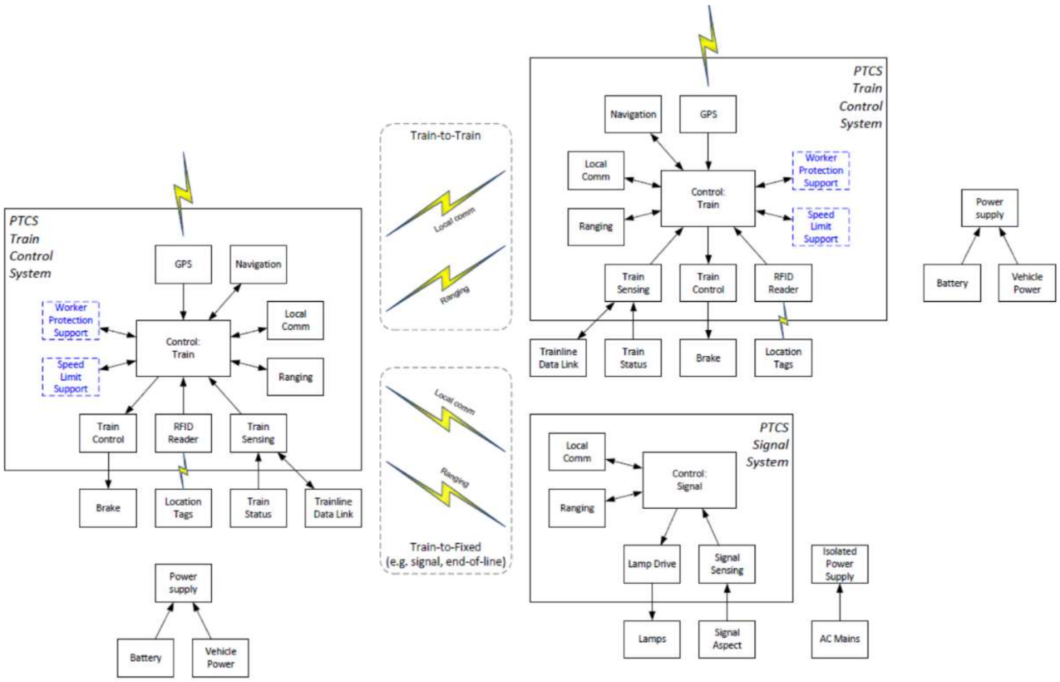
In Boston, the customer requested a non-vital overlay approach. In this concept, the AURA system ensures that the train is operated in compliance with existing signals and operating rules. This system consists of UWB radios embedded in the train and in wayside signals, and at other strategic locations on the wayside (such as end-of-line bumpers and/or worker protection beacons). The train wirelessly communicates with the wayside devices to determine whether intervention is necessary (braking the train).

Equipment deployment is shown below:



Metrom Rail AURA UWB Solution

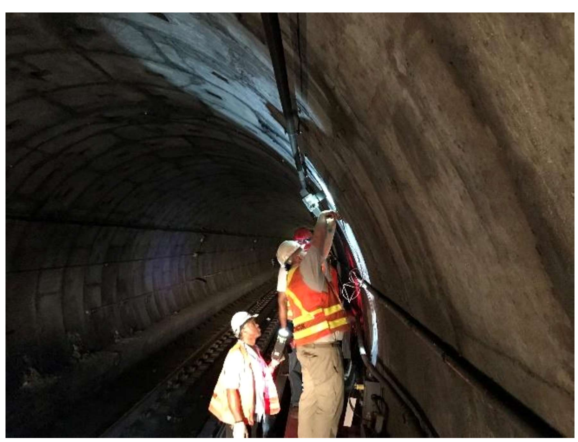
The Boston AURA system utilized multiple sensor inputs to authenticate information. The sensors included GPS, RFID tags, train wheel tachometer, and trainline interfaces (operating status). The AURA system continuously cross checked the sensor inputs to ensure system accuracy and referenced the results against a track map. Train speed is verified using the train wheel tachometer and GPS speed data. Speed restrictions are instituted based on RFID tags and track map data. Train location, direction of movement, and operating track is determined by applying GPS, UWB ranging, wheel speed sensors, and RFID tag scan data to the track map database.



Testing in Boston demonstrated speed limit compliance, signal compliance, and train separation enforcement (such as double-berthing in stations or in un-signaled yard operations), as well as active worker protection, dynamically changing speed restrictions In addition, testing included system redundancy where various fault scenarios were introduced, and the system communicated issues to the operator and acted according to MBTA operating procedure.

New York MTA Solution

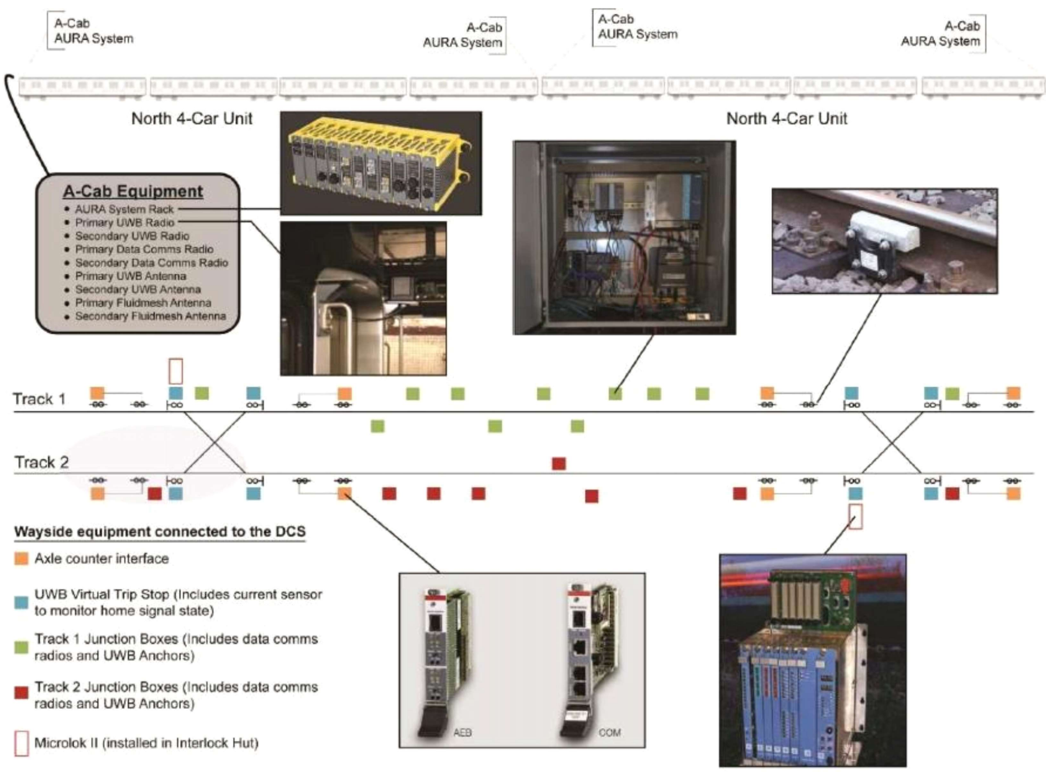
In New York, the AURA system provided speed, position, orientation, train length, and track ID information to a train control system. AURA systems were deployed on both the front and back of the train and an UWB anchor network was deployed along the wayside, see picture below:



Metrom Rail AURA UWB Solution

The wayside anchors allow a train to obtain UWB range measurements to known, fixed geographic positions alongside the track, thus allowing continuous indication of accurate train position on a track map.

Both the train and wayside devices included wireless data communication links for maintenance and diagnostic purposes. The train-mounted data communication allowed continuous updates of the precise position, speed, and direction of the train to a remote monitoring server.



The New York solution was developed utilizing the European CENELEC standards for SIL4 safety. The wayside anchor network was designed so the train is in contact with two to three anchor pairs. The train is designed with two galvanically isolated UWB radios that are cross checked at multiple layers by safety-redundant microprocessors. The anchor UWB radios are also similarly galvanically isolated. The track map, microprocessors, braking interface, and localization algorithm are considered vital subsystems and are designed and tested as such. Fault management is planned and mitigated at every level of development. Any issues in the NY system are communicated to the train operator as well as to the back office through the anchor network. As with existing train control systems, degraded operating procedures would be followed in the event of a catastrophic fault (which are described in detail below).

Mitigating Interference

Every RF system deployed must consider its environment to be successful. Metrom Rail conducts extensive RF surveys prior to demonstrations or deployments. In the surveys conducted, Metrom Rail has experienced no degradation of the performance of the UWB radios. The NY demonstrations were in the test subway track that included leaky coax connected to a high-power UHF radio, ISM-band Wi-Fi, high-speed packet data, and other UWB radios. The AURA system's performance was unaffected.

Metrom Rail AURA UWB Solution

The deployment of AURA systems on both ends of the trains improves the robustness of train localization in the case of extreme interference. This allows identification of train location by independent UWB ranging radio pairs which are separated by 300 to 600 feet.

The systems continuously calculate the safe envelope of operation based on train speed and allow continued operation until deemed unsafe. The train communication to multiple anchors simultaneously assists in making the system safer in that harmful RF interference would need to affect a large area to affect the system.

In the event of interference, Metrom Rail has filtering to mitigate issues. This will continue to be a strategy that is deployed if new emissions affect system performance.

The system response to “harmful RF interference” that inhibits proper UWB ranging operation is addressed in various ways, depending upon the length of the interference interval:

- UWB ranging is configured for several retries for ranging attempts, so if the interference is brief, successful ranging may still occur.
- For automatic train protection implementations, both the front and the rear of the train will have AURA train controllers with independent UWB ranging systems, featuring directional antennas facing forward and rearward, respectively. A single interference source is less likely to disable two UWB ranging systems which are separated by at least several hundred feet.
- The two AURA systems on the train have separate data communication networks, such that if the forward UWB ranging radio is inhibited, location data from the rear can fill brief gaps in ranging data with increased positional uncertainty to cover the possibility of train decoupling.
- Precision accelerometers on the train are interfaced with the control system to provide movement data to compensate for extended periods of RF interference. This information is combined with the last known position and speed data to determine current location and operating speed (with a defined accuracy tolerance).
- In the absence of any other data, when UWB ranging is disrupted by interference for several second intervals, AURA can “dead-reckon” the train position based upon the last known speed, position, and maximum achievable braking and acceleration rates.

In the event the RF interference is so severe and persistent that the radio receiver is overloaded, messages to the operator on the vehicle display will indicate the degraded condition, and, in certain instances, may force a reduction in the speed of the train. Ultimately, each transit authority will specify the course of action in a degraded condition, which may include slowing or braking the train or having the train enter “manual mode” where the operator is in full control of the train.

In the event of strong RF interference:

- If the interference is out-of-band, the radio includes front end high pass and low pass filtering. In addition, the antenna gain at frequencies below 3 GHz provides approximately 20 dB of reduced gain. These factors reduce the probability that out of band interference will saturate the radio.
- If the interference is in-band, coherent averaging of the received signal improves interference rejection. The interference signal tends to appear more noise-like than the properly timed pseudo-random noise coding of the UWB.
- If the signal is so powerful that the front-end amplifier saturates, then UWB ranging may be disrupted. If this occurs for extended periods to a wayside UWB radio, then localized ranging may not be operational and trains may have to enter a restricted mode of operation in the vicinity. If the train-borne UWB radio is saturated, it may be disabled temporarily until it moves out of the high amplitude area. If that period of saturation is brief, the train may be able to dead-reckon/use accelerometer data/use wheel sensor data, if available/use RFID tag detections, if available and at that location; to move out of the interference without degrading normal

operation. If the interference is extended in time and distance, then the train may need to enter restricted mode.

[redacted]

[redacted]

Waiver Request

Metrom Rail has requested permanent installation of UWB radios along the wayside of transit rail lines as well as a 6 dB increase in the directional antenna gain. These requests are limited to along tracks where the RF power is concentrated to a small area that is typically restricted from the general public. The extra gain allows for less infrastructure for deployment as well as more anchors visible to the train which enhances the safety case. Metrom Rail has agreed to provide the FCC with a list of all radios deployed.